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MACROPHYTE-SPECIFIC HABITAT SUITABILITY SCORES AS FIRST-LEVEL ASSESSMENT OF RESTORATION POTENTIAL AND INVASION VULNERABILITY

Background

- Europe requests Good Ecological Water Quality of member states
- Biological restoration occurs, but limited recolonisation by macrophytes
- Passive biotic restoration can favour invasive species[1]

Objectives

- Identify environmental parameters that steer macrophyte presence
- Identify temporal trends in observed and potential macrophyte presence

Materials and methods

- Data-driven modelling (dataset: LimnoData Neerlandica[2])
- Imputation of missing data (random forest-based algorithm)
- Conditional random forests, with independent validation
- Effect of correlated variable and extreme value removal on performance
- Hyperparameter optimisation
- Assessment of variable importance

Result 1: Influential variables supporting restoration

Steering Variables

- Temperature affects macrophyte presence
- Macro- and micronutrients have influence too

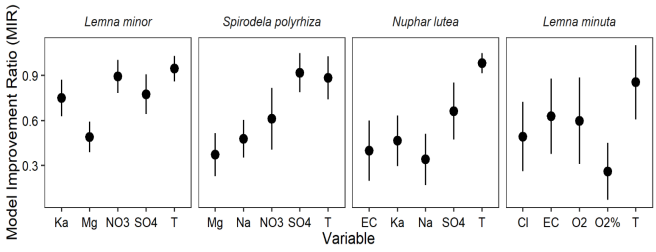

Figure 1: Relative importance of the five most influential variables for each macrophyte. *Relative variable contribution to model performance was assessed for hundred different models. Ka: Potassium; Mg: Magnesium; NO3: Nitrate; SO4: Sulphate; T: Temperature; Na: Sodium; EC: Conductivity; Cl: Chloride; O2: Oxygen; O2%: Oxygen saturation.*

Result 2: Invasion threat suggested by temporal trends

Temporal trends

- Observed and potential prevalence increased over time
- Occupancy of suitable sites remains suboptimal

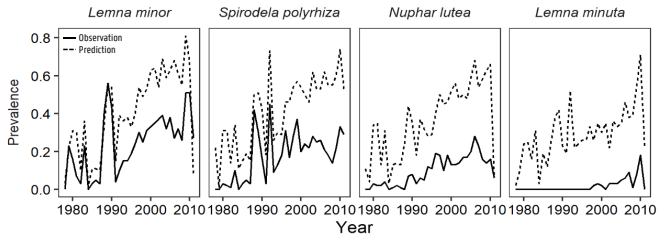

Figure 3: Temporal trend of observed and predicted prevalence. *Suboptimal occupancy of suitable habitats is inferred with predicted (dashed line) prevalence overestimating observed (solid line) prevalence. Predictions were obtained by applying the optimised model on the macrophyte-specific data set and repeated hundred times.*

Restoration focus

- Reducing nitrate (NO3) and sulphate (SO4) discharges in surface waters
- Treat eutrophication of water bodies to reduce pollution presence

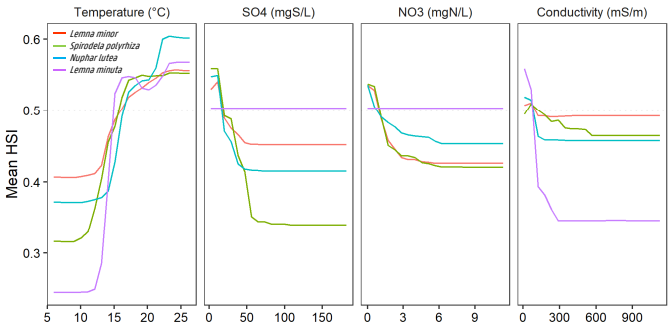

Figure 2: Partial dependence plots for optimised conditional random forests. *For each value along the observed variable's range (twenty breaks between 1st and 99th percentile), habitat suitability index (HSI) of hundred models was determined and averaged. Absence of SO4 and NO3 in the model for* Lemna minuta *provided a stable response.*

Invasion threat

- Occupied sites can inhibit colonisation by introduced species (disturbance can cause exceptions)
- Minority of unoccupied sites support invasive species better

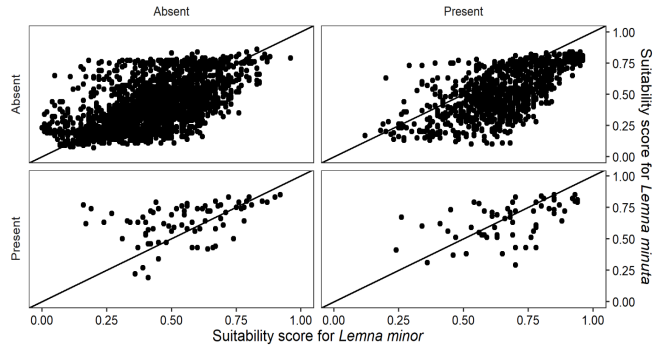

Figure 4: Predicted habitat suitability in function of observed presence/absence. *Sites with absence of both* Lemna *species (top-left,* N *= 2971) indicate the existence of suitable habitats for both* Lemna *spp. Suitability scores were obtained by applying the optimised model to a fixed data set and averaging the result of hundred repetitions.*

Discussion

- Dependence plots suggest that invasive *Lemna minuta* will benefit from reduced pollution
- Suitable sites can remain unoccupied due to dispersal limitations
- Manual introduction can counteract high rates of global change

Conclusion

- Multi-objective restoration management needed for significant changes in habitat suitability index
- Proper site protection and follow-up can limit further spread of invasive species
- Laboratory experiments biotic information can support second-level habitat suitability models

References

[1] Van Echelpoel W , Boets P, Goethals P L M (2015). Functional Response (FR) and Relative Growth Rate (RGR) Do Not Show the Known Invasiveness of Lemna minuta (Kunth). *PLOS ONE.* Volume 11 (11).

[2] Knoben R, van der Wal B (2015). Dutch Foundation for Applied Water Research (STOWA) - Limnodata Neerlandica. Dutch Foundation for Applied Water Research. Occurrence dataset

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